

A.27 Portugal – 1755 – Earthquake

Historical

Keywords: Emergency shelter; Core housing / progressive shelter; Site planning; Infrastructure.

Emergency: 1755 Earthquake, Tsunami and Fire, Portugal.

Date: 1st November 1755.

Damage: Approximately 17,000 destroyed (85% of the housing stock).

People affected: 50,000 died, majority of Lisbon population affected.

Project location: Lisbon.

Outputs: City centre largely rebuilt within 30 years.

Project description:

Following the destruction of most of the housing stock in Lisbon by an earthquake and related tsunami and fire, a complete re-design and reconstruction of the city was undertaken. The new city was designed to include large public spaces, modern infrastructure, and new, anti-seismic building designs.

This historical case study was researched and written by Pedro Clarke and Charles Parrack.



Emergency timeline:

[a] November 1755: earthquake followed by tsunami and 6-day fire.

Project timeline (number of months):

- [1] November 1755: survey of damage.
- [2] December 1755: Five recovery options considered. Law prohibits construction outside city walls.
- [5] March 1756: First reconstruction plans.

[6] April 1756: Number of wooden shelters reaches 9,000.

[2yrs 6m] May-June 1758: Plans authorised, construction begins.

[3yrs] 1759: "Pombaline Cage" design approved.

[30yrs] 1785: Main city completed, population numbers return to pre-earthquake levels.

[83yrs] 1838: Final elements of reconstruction completed.



Situation before the disaster

Despite being the capital of a powerful empire, Lisbon in 1755 had significant levels of poverty, worse than many other European capitals, and was known for problems with violence.

Downtown Lisbon was a densely-populated collection of multi-storey, weakly-built houses with narrow streets. Houses were predominantly masonry structures with timber floors and partitions (Paice 2008, Mata dos Santos 2008).

Impact of the disaster

On the 1st of November 1755, Lisbon was shaken for 10 minutes by an earthquake measuring 8.7 in moment magnitude, and the after-shocks were felt for months. The earthquake triggered a tsunami, with an estimated height of 20 metres, which devastated Lisbon's downtown area. Finally, a fire raged through the city for six days incinerating many of the buildings that were still standing.

As the downtown buildings were built on soft soils and surrounded by steep hills, once the earthquake

struck the whole area folded in on itself (Mullin 1992).

Estimates vary, but according to an amalgamation of accounts by British Merchants and the local authorities the total number of deaths was estimated to be around 50,000, the majority of which lived in the city. This means that one in seven of its inhabitants perished (Paice 2008).

In terms of material losses, an estimated 85% of the buildings of the city were destroyed. This included 17,000 out of 20,000 houses. Of Lisbon's 40 parishes only five were



Following the earthquake, Lisbon was hit by a tidal wave and then a fire that burned for six days. Many in the clergy believed that people were being punished for their sins. Image: 1755 German copperplate image, "The Ruins of Lisbon" Wikimedia Commons, public domain



Portrait of Marquês of Pombal (1699-1782) by Van Loo (1707-1771), Museu da Cidade, Lisbon. Image: Wikimedia Commons, public domain

able to continue with the rituals and celebration of mass and the sacraments: the others were burnt or destroyed.

Situation after the disaster

Although news quickly reached other countries, the UK aid package agreed in parliament two weeks after the disaster did not arrive in port until February due to transportation and customs issues. Spain and France also sent aid, but the initial relief operation was in the hands of the Marquês of Pombal (Paice 2008). Pombal was the then Minister of State and Foreign Affairs and was considering the reconstruction operation at the same time as the emergency response.

The Church provided a great deal of support and the level of cooperation between Church and State was good considering ongoing tensions between the two. Some religious leaders claimed that the city had been punished by God due to its lack of faith (Paice 2008) while many working in government had embraced Enlightenment thinking, and wished to reduce the influence of the Church.

It appears that despite the magnitude of the disaster and the level of need following it, no-one died of hunger. Those whose properties were still intact assisted those in need, housing people in their homes and on their farms (Francisco 2006)

and food in granaries belonging to the King, the Church and the nobility, was distributed.

By royal order, a monastery was set up as a hospital for wounded civilians, while a convent was converted into a military hospital (Francisco 2006). Priests set up local infirmaries in tents and distributed medicine, food and sangria (diluted wine).

Not much information survives on how people coped in the aftermath of the disaster, though the poorest experienced the worst conditions.

Those that had lost their homes camped in the squares, on land owned by convents, and on the beaches. The king ordered a distribution of canvas from the large stockpiles in the royal warehouses, so many people erected makeshift tents. Some supplies were donated by merchants and traders (Francisco 2006).

In the first six months after the quake, it has been estimated that 9,000 wooden buildings were constructed, with settlements developing on the east and west sides of the city. As timber was scarce, much of the lumber had to be brought in from outside (Kendrick, 1956).

Many of the wooden huts were erected as part of government initiatives, others by the church and others by wealthy individuals sheltering those they had immediate responsibility for (Paice 2008). The most famous inhabitants of these wooden

huts was the Royal Family who were sheltered in Royal wooden barracks.

Despite control measures to prevent citizens from leaving it was not until the 1780s that the city's population returned to pre-earthquake levels.

Shelter strategy

Decision-making power was concentrated in the hands of the Marquês de Pombal, whose management of the recovery has been described as "despotic planning" (Mullin 1992).

Pombal immediately passed a series of laws, announcing the death penalty for looting and forbidding people from deserting the city or settling in unplanned camps.

By the end of November 1755, Pombal had commissioned a survey of the damage, and of land ownership, to avoid later disputes over land tenancy (Paice 2008). In December he passed two construction laws, banning construction outside of the city walls or in unaffected areas to prevent unlawful land occupation and low-standard reconstruction. The army was employed to patrol the city and enforce the regulations.

Any temporary building was prohibited until all the debris was cleared and plans for rebuilding were completed. To prevent inflation, construction salaries, rents and the prices of construction materials were all frozen.



Reconstruction planning started in parallel with the relief operation and on the 4th of December 1755 the Chief Engineer, Manuel da Maia, presented a concept paper outlining five broad strategies (Paice 2008):

- Rebuild the city as it was.
- Rebuild the city as it was, but with wider roads.
- Rebuild the city with the same layout but restrict buildings to two storeys.
- Move the city to a new location.
- Demolish the remaining buildings and build a new, modern city.

Pombal opted for the last option even though, or perhaps because, it would involve completely redrawing the map of land ownership in the city. The city would be planned following the progressive spirit of the European Enlightenment and the citizen, rather than the Crown, was to be put at the centre of a modern city.

Land within the Baixa (downtown area) was immediately appropriated by the state and re-allocated, with preference given to existing landowners, or to the administrators who represented the nobles, the church or the crown. Compensation was based only on site area, and not the

post-earthquake building condition, and the medieval property rules and conditions were discarded.

On receiving the deeds, landowners had to agree to complete redevelopment within five years, preventing property and land speculation.

As the new plan for Lisbon involved larger public spaces, some landowners had to be compensated. The compensation plan involved reducing all land lots by a proportional percentage and dividing the Baixa into different zones of value, with a premium being placed on land adjoining public squares.

The effect of the land re-allocation and compensation was to reduce ownership by the nobility and the clergy and increase ownership by merchants, whose investments were in part financing the reconstruction.

This significantly contributed to the increase in economic power of the middle classes, increasing upward social mobility.

The new city

Within a matter of weeks following the disaster, the Marquês had assembled a team of military architects and engineers, led by the country's Chief Engineer, Manuel da Maia, to start discussing plans for the city's reconstruction.

Once the decision had been taken to completely redesign the city, six designs were drawn up and

presented in March 1756 (Mata dos Santos 2008).

The chosen plan featured wide avenues connecting two main squares and a restriction of building height to 3 or 4 storeys (considered to be more resistant against collapse). In further iterations of the plan, city infrastructure was to be greatly improved, with a modern water supply for the general public. Building components and construction processes were standardised in order to increase the efficiency of the reconstruction process and houses were designed to be earthquake-resistant.

In May 1758 the plan was officially approved and the reconstruction began.

The modernisation of the city created a robust rental market (Do Couto da Silva, 2012). The house designs allocated the ground-floor space to shops and workshops, the middle storeys to the middle classes whilst the lower-standard attic-floors were reserved for servants and the working classes (Wall Gago 2007). This is one of the first modern examples of people from different social classes living in the same buildings (Cornelio da Silva, 2006).

Reconstruction of the city centre took around 30 years from the 1750s, but other parts of the city were not completed until as late as 1838, still following the original plan. By 1780 the number of dwellings had surpassed the pre-earthquake numbers (Pereira 2006.)

Disaster Risk Reduction (DRR)

Part of the plan was that all buildings should be built to the latest in anti-seismic design, and Pombal ordered the destruction of any houses not meeting the specifications (Mullin 1992).

The new anti-seismic design by Carlos Mardel included an internal timber-frame with an embedded post-and-beam construction with high levels of bracing. The frame was filled with rubble and then plastered to add protection against fire. The design became known as the "Pombaline Cage" and the first building began in 1759, a year after



A model showing the Pombaline cage design. The design is said to have been tested by getting the army to walk up and down on the roof of a full-size model.

Photo: Galinhola, 2008. wikipedia.org/wiki/File:Gaiola_pombalina.jpg

the initiation of the reconstruction process.

The design was apparently tested by running a stress-test on a full-scale model in the city's main square. The military were ordered to march in uncoordinated, uneven rhythms on top of the building to simulate the tremor conditions of an earthquake (Mata dos Santos 2008).

Issues today

Recent studies by some Portuguese engineers (Cardoso, Lopes and Bento 2004, and Ramos, Lourenço 2000) suggest that many of Pombaline Cage buildings in the Baixa have been profoundly altered, driven mainly by commercial interests and changes in building use. This would suggest that some parts of the city might now be more vulnerable than they were 200 years ago.

References

- Cornelio da Silva, Gonçalo. 2006. Speech at the First Congress of Marvila, Lisbon.
- Do Couto da Silva, Miguel Angel. 2012. Aprender História pelo espaço: o caso da Baixa Pombalina. Universidade do Porto.
- Cardoso, R., Lopes, M. L., Bento, R. 2004. Earthquake Resistant Structures of Portuguese Old Pombalino Buildings 13th World Conference on Seismic Engineering, Vancouver, Canada.
- Kendrick, T. D. 1956. Shelter in response to the Lisbon earthquake of 1755. cited in IFRC 2013 Shelter Projects 2011-12 p. xiii.
- Mata dos Santos, Maria do Céu Ferreira. 2008. ESTUDO DOS DANOS OCORRIDOS EM LISBOA CAUSADOS PELO TERRAMOTO DE 1755: QUANTIFICAÇÃO E DISCUSSÃO [Online] Available at: https://fenix.tecnico.ulisboa.pt/downloadFile/395137857471/Tese_C%C3%A9u_IMPRIMIR_ENTREGA_FINAL.pdf (accessed 08th of June 2014)
- Marques, João Francisco. 2006. "A Acção da Igreja no Terramoto de Lisboa de 1755: Ministério Espiritual e Pregação". Lusitania Sacra, 2a Serie, 18.
- Mullin, John R. 1992. The reconstruction of Lisbon following the earthquake of 1755: a study in despotic planning. UMass Amherst [Online] Available at: http://scholarworks.umass.edu/larp_faculty_pubs (Accessed 06th of February 2014)
- Paice, Edward 2008. Wrath of God: the great Lisbon earthquake of 1755. Quercus. London.
- Pereira, Alvaro S. 2006. The Opportunity of a Disaster: The Economic Impact of the 1755 Lisbon Earthquake. Centre for Historical Economics and Related Research at York.
- Ramos, L. , Lourenço, P. 2000. Análise das técnicas de construção pombalina e apreciação do estado de conservação estrutural do quarteirão do Martinho da Arcada. Universidade do Minho. Departamento de Engenharia Civil. "Engenharia Civil". ISSN 0873-1152. 7 (2000). p. 35-46.
- Wall Gago, Catarina. 2007. Habitação na Baixa Pombalina: Análise de Tipos e Estudo de Intervenções. Instituto Superior Técnico.